An Assessment of the Arctic Char Population of Tugaat River, Nunavut

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by

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ABSTRACT

Read, C.J. An assessment of the Arctic char population of Tugaat River, Nunavut. Can. Manuscr. Rep. Fish. Aquat. Sci. 2699: v + 35 p.

The Tugaat River Arctic char population is important in meeting the nutritional and cultural needs of the residents of Pond Inlet, Nunavut. The results of a 1980 Department of Fisheries and Oceans (DFO) tagging study at Tugaat River indicated that the population was being heavily exploited. A 1985 harvest sample indicated a decrease in growth of the population. This information led DFO and the Pond Inlet Hunters and Trappers Association to agree on a quota reduction from 1400 kg to 1000 kg. In response to further concerns by local fishers, DFO undertook a weir assessment of the char upstream migration in 1992. The results of the weir study, previous data (including fishery observations), and subsequent harvest samples have all been considered in an assessment of the Tugaat River char population.

A bimodal length frequency, a favourable condition factor (1.17), a growth rate similar to other Arctic populations, the presence of old char along with a relatively low fishing mortality, an increase in mean length indicated by harvest samples, and fisher observations, all point to a stable stock. The low fish count of 1992 may be the result of yearly fluctuations in migration into Tugaat River, or may be due to the lack of over-wintering capacity, suggesting that the Tugaat River population is, and always was, relatively small.

Key words: Arctic char, Tugaat River, weir, upstream migration, gill nets, tagging, fishery observations, growth, condition factor, mortality.

RÉSUMÉ

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La population d'ombles arctiques de la rivière Tugaat constitue un élément important de réponse aux besoins nutritionnels et culturels des résidants de Pond Inlet, au Nunavut. Les résultats d'une étude après marquage menée en 1980 par Pêches et Océans Canada (MPO) dans la rivière Tugaat faisaient état d'une exploitation exhaustive de la population. En 1985, un échantillon de la récolte indiquait une baisse de croissance de la population. Ces données ont mené le MPO et l'Association des chasseurs et trappeurs de Mittimatalik à s'entendre sur une réduction du quota de pêche de 1 400 kg à 1 000 kg. En réaction à des préoccupations ultérieures des pêcheurs locaux, le MPO a entrepris en 1992 une évaluation de la passe migratoire des ombles en amont. Les résultats de l'étude de la passe, les données biologiques antérieures, les observations relatives aux pêches et les échantillons subséquents de récolte ont tous été pris en compte dans l'évaluation de la population d'ombles arctiques de la rivière Tugaat.

De nombreux indices suggèrent que le stock est stable : longueur de fréquence bimodale, coefficient de condition positif, taux de croissance semblable à celui d'autres populations boréales, présence de vieux ombles, mortalité des poissons assez faible, augmentation de la taille moyenne (observée dans les échantillons récoltés), et remarques des pêcheurs. Le faible nombre de poissons en 1992 peut dépendre de fluctuations annuelles de la migration dans la rivière Tugaat ou être lié à l'absence de capacité d'hivernage. Il se pourrait donc que la population de la rivière Tugaat soit, depuis toujours, relativement petite.

Mots clés : omble chevalier, rivière Tugaat, passe, migration d'amont, filet maillant, marquage, observations sur les pêches, croissance, coefficient de condition, mortalité.

INTRODUCTION

Arctic char, *Salvelinus alpinus* L., have a circumpolar distribution with the anadromous form occurring in coastal streams throughout its range (Scott and Crossman 1973). Anadromous char are found in many of the lakes and rivers along the north coast of Baffin Island (Fig. 1). These fish stocks are extremely important in meeting the nutritional and cultural needs of the area residents.

In 1992 the Department of Fisheries and Oceans (DFO), in order to address concerns expressed by Pond Inlet fishers regarding the declining size and relative abundance of the Tugaat River Arctic char stock, undertook a weir assessment of the Tugaat River upstream migration. The specific question being adressed was, "Can the Tugaat River char stock sustain the present fishing pressure?" Data collected from the weir study, as well as from a 1980 tagging program are presented here to address this question. This report also includes data collected to monitor changes in the stock over time. Monitoring data was collected from 1975 to 2000, primarily by the Pond Inlet Wildlife Officer, Department of Sustainable Development (DSD), Government of Nunavut (formerly Government of the Northwest Territories).

The Tugaat River (72° 04'N 80° 21'W) flows into Milne Inlet, approximately 120 km southwest of the community of Pond Inlet, Baffin Island, Nunavut (Fig. 1). Upstream access to the one large lake system on the river (Icebound Lakes) is blocked by a waterfall approximately 70 km from the mouth of the river (Fig. 2). Between the falls and the mouth of the river there are several "lakes" (widenings of the river) which provide the only known over-wintering areas for Arctic char in this system. One of these widenings, where winter fishing takes place, is referred to locally as Tugaat Lake (Fig. 2).

There are no records of the subsistence harvest from Tugaat River but there are commercial harvest data for some of the years between 1977 and 1996/97 (01 November 1996 to 31 October 1997, Table 1). In 1985 the commercial quota was reduced from 1400 to 1000 kilograms (kg) , at the request of the Mittimatalik (Pond Inlet) Hunters and Trappers Organization (HTO), with advice from DFO. This advice was based on the 1980 tagging recapture information and a 1985 gill net sample provided by DSD.

As a result of the low fish count from the 1992 weir study, the Mittimatalik HTO, in consultation with DFO, closed the system to commercial fishing, starting with the 1993/94 fishing season. As a result of the closure, the Tugaat River char stock was thought to be recovering. In 1999 the HTO approached DFO for advice in regard to reinstating the commercial quota. DFO advised the HTO that a one-year experimental fishery should be undertaken to collect some current data before implementing any changes in the management of the fishery. To date, DFO has not received this data or any further requests to have the Tugaat River fishery opened to commercial fishing.

METHODOLOGY

1992 WEIR AND TRAP

A one-way fish counting weir and trap was constructed in the Tugaat River to enumerate the 1992 upstream migration of Arctic char. The weir was located approximately 2 km upstream from the mouth of the Tugaat River (Fig. 2). The weir was constructed in a V-shape to lead the upstream migrant fish into and through the trap. The trap was located at the apex of the weir thus providing a temporary barrier to allow counting and sampling of the fish. The design and construction of the weir were similar to the conduit pipe and metal design described by Anderson and McDonald (1978), with modifications as described in McGowan (1987), using aluminum angles, channels and pipes.

Monitoring at the weir began on 09 August and ceased on 28 August, when the number of char migrating upstream had decreased to fewer than 100 per day. The number of times during the day that fish were processed was adjusted in relation to the number of fish moving upstream that day. Morning and evening checks were conducted daily with additional checks during the peak of the run to prevent crowding of fish in the trap.

Every fish in the trap was processed; they were either sampled (dead or live), tagged, or simply counted and released upstream of the trap. The dead sample consisted of char stratified by 50 mm length class intervals with at least 10 char from each interval, sacrificed intermittently throughout the migration. The dead sample was measured for fork length to the nearest millimetre (mm), round weight to the nearest gram (g), the state of maturity determined (according to App. 1), and otoliths removed for age determination.

Both the live sampled and the tagged fish were measured for fork length to the nearest mm and round weight to the nearest g. For each fish tagged, a T-bar anchor tag bearing a reference number and a DFO address was attached, using a tagging gun. Tags were inserted in the left side of the fish at the base of the dorsal fin such that the T-bar was anchored behind the basal pterygiophores. The fish were released upstream of the weir.

Tag recapture information was obtained from subsistence and commercial fishers from the community of Pond Inlet. Approximately one quarter of the 1992 tags recaptured from the subsistence fishery in February 1995 were accompanied by length, weight and mesh size information. Lengths and weights (N=386) were also collected from the December 2000 subsistence fishery which included 17 tagged fish.

HARVEST SAMPLES

Biological information was collected from Arctic char harvested from Tugaat River in the summers of 1980 and 1995, and from Tugaat Lake in the winters of 1975, 1985, 1996 and 2000. Fork lengths, round weights and aging structures (otoliths) were taken for all samples except the 1985 and 2000 samples (no otoliths). The summer (August) samples were taken from the river, thus, sampling only the sea-run char. The winter samples (May, December and February) were taken from the lake, thus sampling the over-wintering population. The February 1996 and December 2000 samples were not separated by mesh size.

1980 TAGGING

Arctic char were tagged at the Tugaat River on 09 and 10 August 1980. Gill nets of 38 mm and 63 mm meshes were used to capture the fish. The fish not tagged were dead sampled.

AGE DETERMINATION

The char ages were determined from sagittal otoliths. Upon extraction from the fish, the otoliths were stored dry in coin envelopes. In the laboratory they were ground on a fine carborundum stone and placed in benzyl benzoate for clearing before being examined under a binocular dissecting microscope. A reflecting light source against a black background was used to highlight the annual growth rings which were counted to determine an age. Age determination prior to and including 1989 was done according to Grainger (1953) who considered the dark core of the otolith representative of the first winter of growth. Age determination for the years after 1989 was conducted according to Nordeng (1961) who did not consider the dark core to be the first winter of growth. In this report the ages for the years before 1990 (aged according to Grainger 1953) were reduced by one year to be comparable with those samples aged after 1989 (aged according to Nordeng 1961).

DATA ANALYSIS

The Statistical Analysis System (SAS 1999) was used to generate statistics and tabular summaries of length, weight, age , sex and maturity data for all Arctic char sampled.

Relative condition factor (K), a measure of the relative robustness of the fish, was determined from the following formula:

$$K = \frac{W \times 10^5}{L^3}$$

where W = round weight in g and L = fork length in mm.

The condition factor is considered a more satisfactory method of comparing the condition of stocks than weight-length relationships in which

the largest and smallest fish tend to skew the value (Johnson 1980). Distortions in the condition factor can be largely eliminated by using a predetermined number of length groups on either side of the modal value. The mean K of five 50 mm length groups (the modal length and two on each side of the modal length) for the sites mentioned here is similar enough to the K for the total sample (0 to 0.04 difference) that the K value for the total sample is used here.

The total estimated weight of char 400 mm and over in the upstream run (used to estimate a sustainable harvest rate) was calculated as the sum of the mean weight of the fish sampled in each length interval multiplied by the estimated number of fish in that length interval.

The length frequency for the entire 1992 upstream migration was estimated on a daily basis as follows and then summed to get a total for that length interval:

$$N_i \times \frac{SL_i}{S_i}$$ where,

N_i = total count on day $_i$
SL_i = for a given 50 mm length interval, the number of fish sampled on day $_i$
S_i = total number of fish (from all length intervals) sampled on day $_i$

The age frequency for the entire 1992 upstream migration (used in Fig. 7) was calculated by first estimating the number of char within a given age class as follows and then combining those estimates to get the age frequency distribution for all char passing through the weir:

$$N_j \times \frac{A_j}{S_j}$$ where,

N_j = estimate of number of fish within length interval $_j$
S_j = for a given age, the number of fish within length interval $_j$ in the dead sample
S_j = the number of fish for all ages within length interval $_j$ in the dead sample

A catch curve was constructed by plotting the running average of three age frequencies against log age. Instantaneous mortality rate (Z), was then calculated using a least squares regression on the descending limb of the catch curve. Only age groups that were fully recruited into the catch were used (10 -19 yrs) following Ricker (1975).

RESULTS AND DISCUSSION

1992 WEIR AND TRAP

A total of 6534 Arctic char were counted passing upstream through the Tugaat River weir, 9-28 August 1992 (Fig. 3). Of this number, 2369 (36%) were tagged and released; 1529 (23%) were live sampled and released; 212 (3%) were dead sampled; the remainder were counted and released (Table 2). The major peak of the upstream migration occurred on 19 August (18% of the migration) with a smaller peak occurring on 14 August (8% of the migration).

Length

Fork lengths were taken from a random sample (live and tagged) of 3896 char at the Tugaat River during the upstream migration (Table 3). The length-frequency distribution of these char was bimodal (Fig. 4h). The primary modal length interval was 250–299 mm and the secondary one was 450-499 mm. In 1989 the upstream run of char in Ikaluit River (Fig. 4g) had a modal length class of 450-499 mm. There was a small peak at the 250-299 mm interval. Both rivers are the source of important fisheries for the community of Pond Inlet. Of the two populations, Tugaat had a much smaller upstream run (6534 vs. 282,567) and a mean length 65 mm less. The results of weir studies in the central high Arctic show upstream runs with more of a unimodal length frequency distribution, modal length intervals 50-200 mm larger and mean lengths 74-190 mm more than in Tugaat River (Fig. 4a-f).

Research suggests that the stable equilibrium state for Arctic fish populations is a bimodal size frequency distribution (Johnson 1976, 1980, 1989). The 1992 upstream run in Tugaat River, indeed, showed a bimodal size frequency distribution with a strong representation of juveniles (250-299 mm). Several years of little to no fishing up to 1992 (Table 1) may have allowed a buildup of juveniles ready to move into the recruitment stage. Personal observations

(George Koonoo pers. comm.) and tag returns (in 1994, 84 tags were returned including 23 from one fisher) indicated that, as early as 1994, fishing success at Tugaat River had increased. Fish 400-549 mm in length that were tagged in 1992 and caught two and a half years later had grown, on average, 60 mm per year (Table 4). Fish in the primary modal length class in 1992 (250-299 mm), because smaller fish generally grow faster than larger fish (Grainger 1953, Moore and Moore 1974), would then be more than 130 mm longer (380-429 mm) and therefore, of recruitment size by August 1994. This large juvenile segment becoming adults and vulnerable to the fishery could have been the reason for the reported improvement in fishing at Tugaat River.

It has been suggested that the largest fish are the first to move upstream in the fall (Andrews & Lear 1956, de March et al. 1978). Johnson (1980) found this size precedence more apparent in the downstream run (spring) than the upstream run. In the Tugaat River 1992 upstream migration there was no apparent segregation of the size classes. Each length interval was fairly evenly distributed throughout the duration of the weir study (for days when n >20, Fig. 5). The most prominent peaks in the upstream run (14 and 19 August, Fig.3) do not represent the peak number of fish in any given length class (Table 2).

Maturity and Sex Ratio

The age of first maturity (the earliest age at which maturity was first noted) for char at the Tugaat River was 7 years for males and 10 years for females (Table 5). Compared to other selected populations it is lower than most, except Ikaluit River and males in Diana River (Table 6). Lowered or declining age of first maturity can be one response of a stock to heavy fishing pressure. This may be the case at Tugaat River but due to an absence of historical data (no maturity data prior to 1992) there is no evidence that the age of first maturity has declined.

Sex ratios for the sea-run (non-spawning) portion of an Arctic char population tend to approach equality (Johnson 1980). The sex ratio at Tugaat River in 1992 was 1.3 : 1 in favour of the females. Sex ratios in other sea-run populations in the Canadian Arctic ranged from 0.5:1.0 in favour of males to 1.5:1.0 in favour of females (Table 6).

Growth and Condition

Arctic char tagged at Tugaat River in August 1992 and recaptured in February 1995 (approx. 2.5 years later) grew an average of 60 mm per year (Table 4). Char in the length interval of 400-449 mm grew an average of 72 mm per year. These annual growth increments steadily decreased to 32 mm per year for fish in the 650-699 mm length interval. One fish tagged in the 700-749 mm length interval gained an average of 79 mm per year until it was recaptured.

Mean lengths at age for the 149 Arctic char aged from the Tugaat River weir indicate growth rates similar to that of char taken at several other Arctic rivers, all of which were subject to exploitation (Fig. 6). Diana River with a faster growth rate and Sylvia Grinnel River with a slower growth rate, were both considered to be over-exploited stocks at the time of the respective studies.

The condition factor (K) was 1.17, for char moving upstream in the Tugaat River in 1992 (Table 6). Variability in this index among and within systems reflects the quality and quantity of available food in any given year and season. The condition factor is much greater in August when the fish are coming back from a summer spent feeding in the ocean, than it is after spawning when little to no feeding takes place. Compared to other char populations at the same time of the year, the Tugaat River population was less robust than the average (K=1.23). This may be due to the high percentage of small fish (34% of the sample <300mm). In general, small char have lower K values.

Mortality

The assumptions of constant recruitment and mortality among age classes are required for regression derived mortality estimates. The relatively straight descending limb of the catch curve (Fig. 7), indicates uniform mortality within age classes. Good recruitment of age classes is

indicated by the constant decline of representation of age classes. The r^2 value of 0.91 indicates a good fit over the ages 10 to 19 years. Instantaneous total mortality of Z = –0.49 suggests that the stock is exploited. If natural mortality, M, is assumed to be about 0.17 (Moore 1975b; Dempson 1978), then fishing mortality, F, can be calculated as F = Z-M, or F = 0.4 9-0.17 = 0.32. This level of fishing mortality has been observed among stocks of Arctic char that are known to be lightly exploited. Overall, the presence of old char in the catch and a relatively low fishing mortality, suggest that the stock is stable. The critical assumption is that the data used are representative of a single stock of Arctic char, and not a mixture of more than one stock.

Stock Discreteness

The results of both the 1980 and the 1992 tagging studies support the assumption that Tugaat River charr have a strong fidelity to that system. In 1980 DFO tagged 196 Arctic char at the Tugaat River. During the winter fishery in November 1981, 75 tags were returned (38% of the tagged fish) and all of the recovered tags (except one for which no recapture location was given) were recaptured in Tugaat Lake (Table 7). By the end of 1982, 50% of the tags had been returned and all (except two for which no recapture location was given) were recaptured in the Tugaat River system.

Two hundred and seventy-nine (76%) of the 365 tag returns from the 1992 tagging operation were recaptured in the Tugaat River system (Table 8). The 84 tagged char recaptured in Milne Inlet were as likely to overwinter in Tugaat Lake as elsewhere. They were caught in August, about 15 to 20 km from the mouth of the Tugaat River in coastal staging/summer feeding areas prior to their upstream migration. Robertson River and Phillips Creek, located 25 km and 30 km respectively from Tugaat River (Fig.1), are other possible destinations for char from Milne Inlet. The extent to which Tugaat River fish may use these other rivers is not known since little or no fishing takes place at either river. Although there is ample evidence of "mixed stocks" in the central Arctic (Cosens, S.E. et al 1990), there is little evidence of "mixed stocks" in the Pond Inlet area; two Tugaat River tags were recaptured elsewhere (in Ikaluit River).

The management of Arctic char fisheries in the Canadian Arctic is based on the assumption that each river system supports a discrete stock which has a high fidelity rate to the natal stream (Kristofferson et al 1984). That is, there is a high probability that the fish leaving a river system in the spring to feed in the ocean will return to that same system in the fall. In Nauyuk Lake, central Canadian Arctic, fidelity was highest in fish between 350 mm and 600 mm, in some cases approaching 100% (Gyselman 1994). Fidelity decreased rapidly for fish over 650 mm. What appears to be a much lower fidelity rate in smaller fish may actually be a higher mortality rate, caused by physiological stress, higher predation rates and/or higher tagging mortality which occurs among smaller char (Johnson 1980). The tag recapture data supports the premise of a high fidelity rate among the Tugaat River system char. All except two Tugaat River tag recaptures were in or near the Tugaat River system. Similar to the Nauyak River system, fidelity of the Tugaat River char was much lower in smaller fish (<350 mm). Only 4% of the smaller fish tagged at Tugaat River in 1992 were recaptured. The overall recapture rate was over 16% (Table 8). A higher mortality rate, rather than a low fidelity rate, is more likely the reason for the low number of tag recaptures (Gyselman 1994). The fact that all fish, but two, tagged at Tugaat River were recaptured in or near the Tugaat River system supports the assumption of a discrete stock.

Habitat

Over-wintering habitat could be a limiting factor for the number of Arctic char in the Tugaat River population. There is no accessible lake in the system of the size available to support a large population such as recorded in the Ikaluit River system and other river systems in the central Canadian Arctic (Read 2000; McGowan 1987, 1990; McGowan and Low 1992). The major over-wintering site in the Tugaat river is a widening in the river where the winter fishery takes place (locally called Tugaat Lake). This could be a factor that limits the size of the population.

TAG RETURNS

One hundred and ninety-six fish were tagged and released at Tugaat River 08 and 09 August 1980. Although most fishing at Tugaat River takes place during the winter, there were no substantial numbers of tag returns until November 1981 (Table 7). There was a commercial harvest reported in 1980 so fishing did take place (Table 1). The fish were tagged in two days and may not have dispersed among the total population but remained as a group in a location of the lake that was not fished in the 1980 fishery. Presumably, in the following year the tagged fish would have been well dispersed within the total population and would therefore be no more or no less vulnerable to the fishery than untagged fish of a similar size. There were 75 tag returns from the November 1981 fishery. With no regard for mortality (natural or tag), that represents an exploitation rate of 38%; taking mortality into consideration (and presumably there was some) would result in an even higher exploitation rate. This high exploitation rate was a deciding factor in the reduction of the Tugaat River commercial harvest from 1400 kg to 1000 kg in 1985.

In August 1992, 2369 (36%) of the upstream migration of Arctic char in the Tugaat River were tagged. To date, 365 tags have been returned (Table 8). The first substantial number of tag returns was in February 1995. Three individual fishermen caught approximately 219 fish (680kg/3.1kg, Table 9) of which 84 (38%) were tagged fish. In subsequent years, the annual average proportion of tags in the total catch of individual fishers was 13% in 1998 (fishers=2), 5.8% in 1999 (fishers =2), 7% in 2000 (fishers =3) and 10% in 2001 (fishers =1). The number of tags still being caught (8 tags) after 10 years is indicative of longevity and low mortality in the over 400 mm length intervals. Of the 175 tagged fish under 400 mm only seven (4%) have been returned. This is indicative of high mortality in smaller sea run Arctic char, as stated by Johnson (1980). The length interval mode of 250 to 299 mm comprised over 25% of the total upstream run which would compensate in part for the high mortality rate of that length interval.

HARVEST

Length and age frequencies of the harvest samples of Arctic char from Tugaat River/Lake are shown in appendices 2-13. A summary of the results of these gill net samples collected from 1975 to 2000 is shown in Table 9. The samples from 1975, 1985, 1996 and 2000 were all taken from Tugaat Lake during the winter. As different mesh sizes were used during this period, comparisons were not made. However, the 1980 and 1995 harvest samples were both taken from the river in August; both with 140 mm mesh gill nets. The mean length of the char increased from 550 mm in 1980 to 713 mm in 1995. This increase in size is consistent with the observations of the local fishers who noted that the fish size had generally increased from the 1980's to the early 1990s. This increase may be representative of the general population, related to a size class segregation in the run, and/or due to the small sample size in 1995 (N=30). The range in length intervals was 350-399 mm to 755-799 mm in 1980 and 600-649 to 800-849 mm in 1995. Forty percent of the fish in 1980 were more than 600 mm in length; in 1995 all the fish were greater than 600 mm.

The change in mean age from 1980 to 1995 does not reflect the corresponding increase in mean length. The mean age decreased from 14.3 in 1980 to 13.0 in 1995, with an age range of 10-24 years in 1980 and 10-21 years in 1995. The rate of growth may have increased to compensate for depletion of the stock or it may be a product of the small sample size in 1995.

Johnson (1980) concluded that an annual harvest rate of 11% per year for Arctic char 400 mm and over in the upstream run of Nauyuk Lake (central Canadian Arctic) was excessive. For many years now the commercial fisheries of Cambridge Bay (central Arctic) have been successfully managed using a 5% annual harvest rate (Kristofferson et al 1984). On the basis of the experimental work of Johnson (1980) and the practical experience at Cambridge Bay, a sustainable harvest level for Arctic char is considered to be between 5% and 10%. The number of char 400 mm and over in the 1992 Tugaat River upstream migration was estimated to be 3440 fish and their total weight 5894 kg. A safe harvest level for Tugaat River based on the

1992 weir data would therefore be between 295 kg (5% of 5894 kg) and 589 kg (10% of 5894 kg). Minimum annual commercial harvest has been at least 1000 kg since 1995 (Table 1), in addition to the subsistence harvest which is virtually unknown except for the minimal estimate gleaned from information collected from fishers on submission of tags for the reward (Table 8). This safe harvest rate of 5% to 10% of fish 400 mm and over is based on limited research and a small number of management examples (Cambridge Bay area), therefore, the extent to which this rate is an optimal total allowable catch for char populations over a broad geographic area is unknown.

Hunter (1970) suggested that Keyhole Lake (central Arctic, Victoria Island) could be harvested at half the standing stock and if left fallow for three years it would recover to 88% of the original stock, 97% in five years. There has been no commercial fishing at Tugaat River since the 1992 enumeration. There presumably was no subsistence harvest until 2 years later since there were no tag returns until then. The community was informed of the low fish count (6535 compared to the 282,567 fish counted at the Ikaluit River in 1989, Read 2003) so they would be less likely to go that distance to fish. There was no commercial fishery from 1988 (no information for 1987) to the present, with the exception of 1990/91 when there was a minimal harvest (329 kg). Therefore, when the 1992 enumeration took place, the fishery may already have been in recovery. The 27 tagged fish caught in 1994 represent an exploitation rate of 1.8% which would be of little consequence to the population.

FISHER OBSERVATIONS

Arctic char were visibly abundant in the Tugaat River in the early 1970s (Government of Nunavut, unpublished data). However, fishers reported a decline in the quantity and size of the fish in their catches in the early to mid-1980s (Mittimatalik HTO, pers. comm.). By the mid 1990's the trend was starting to reverse (Table 8, see Remarks) and by 1998 fishing at Tugaat Lake was reported as "excellent". In December 1998, over 300 fish were caught in approximately 36 hours of fishing with 89 mm and 140 mm mesh gill nets. The smaller nets caught fewer fish although the length of time that the nets were in the water was not noted. The fish were reportedly large and fishing was good, similar to the 1970s (George Koonoo, pers. comm.).

A December 2000 fishing trip resulted in similar "glowing" reports regarding size and abundance of fish in Tugaat Lake. It was "really good fishing" (George Koonoo, pers. comm.) The biggest fish of the 386 that were weighed and measured was 7.5 kg and 840 mm (App. 13). The people of Pond Inlet prefer Tugaat char over Ikaluit River char, a major Pond Inlet fishery (see Fig. 1). The Tugaat River fish taste better.

In November 2001, one fisher reported catching 200 fish and another 200 in December. This same fisher reported that there were more fish in November/December 2001 than in 2000. In November 2001 three other fishers caught approximately 350 fish between them (George Koonoo, pers. comm.).

CONCLUSIONS

It may be advisable that Tugaat River remain a subsistence fishery only, with no commercial quota. The stock was unable to sustain both fisheries in the past. The people of Pond Inlet consider the quality of Tugaat River Arctic char to be superior to other stocks in the area and consequently, take a large amount of char from this system for their annual community Christmas feast.

The information received from the subsistence fishery indicates the use of 89 mm to 140 mm mesh gillnets. The use of 140 mm mesh size gill nets for all anadromous Arctic char should be discussed with and encouraged by the HTO.

Catch and effort data along with a biological sample from the pre-Christmas harvest would provide valuable on-going data on the fishery.

Long-term monitoring including a harvest monitoring program that could be implemented by the HTO and carried out by the fishers themselves would provide valuable information for future evaluations.

ACKNOWLEDGMENTS

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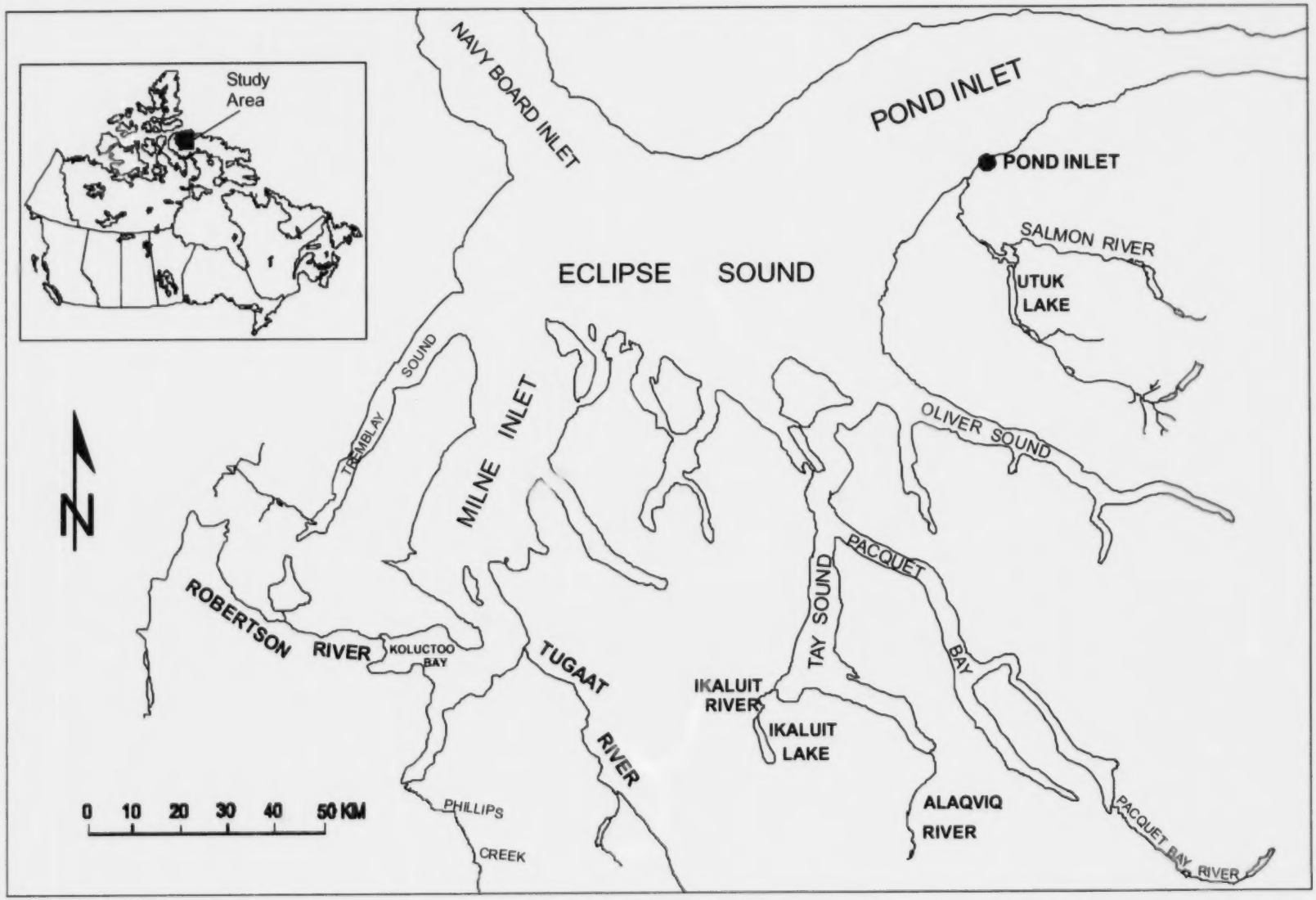

Fig. 1. Map of Pond Inlet area, north Baffin Island, Nunavut, showing the locations of selected commercial and subsistence fisheries.

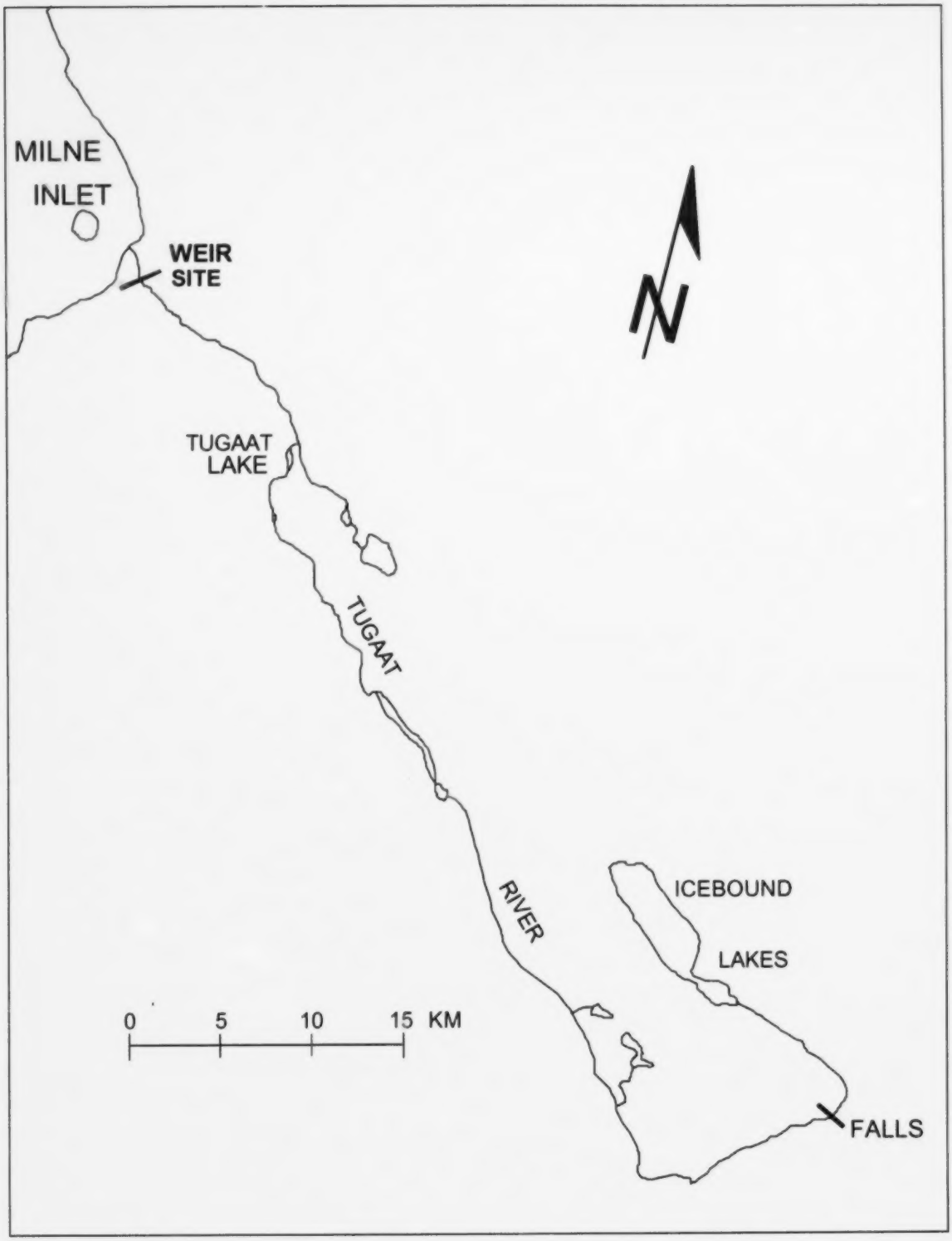

Fig. 2. Map of Tugaat River showing the 1992 weir site.

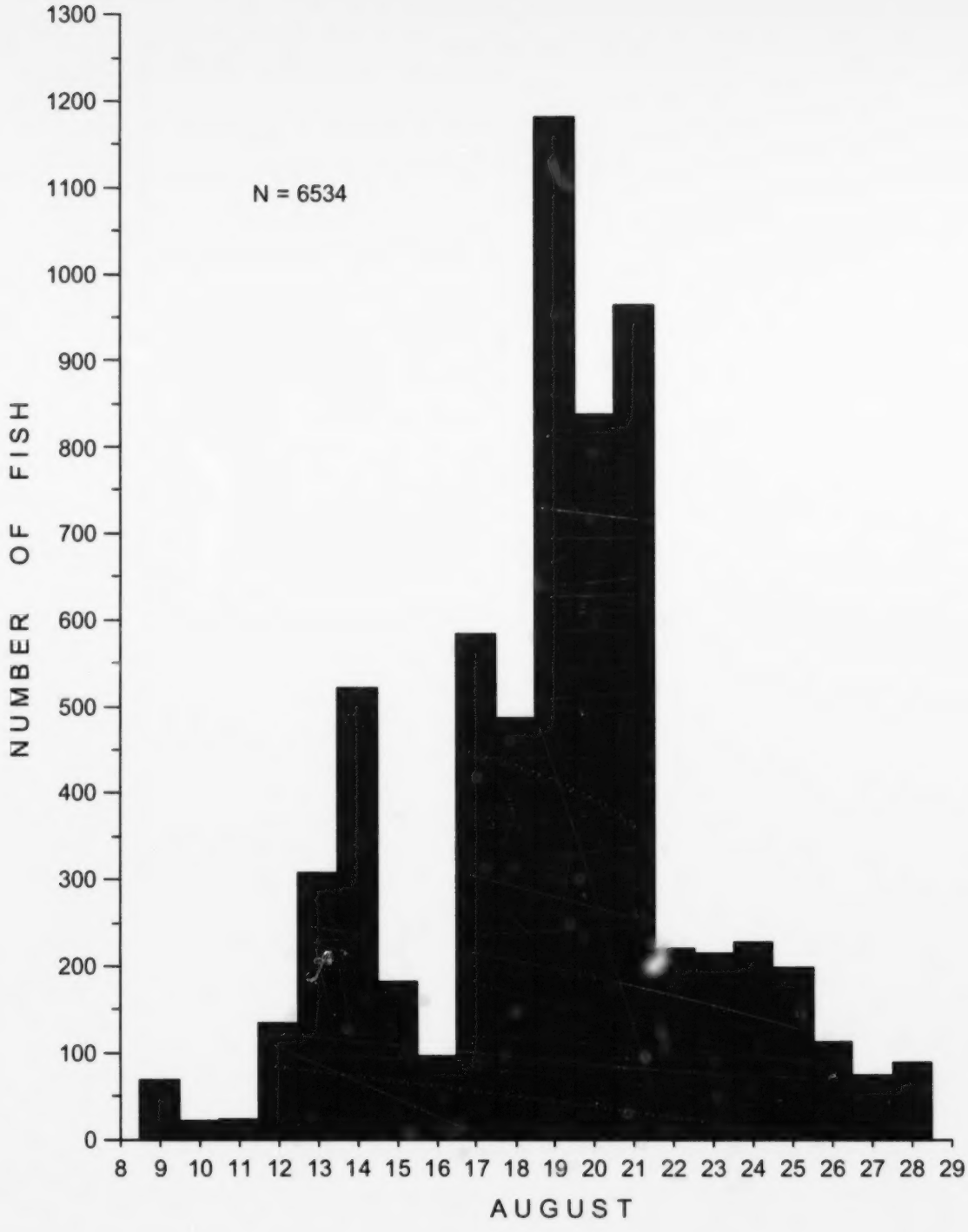

Fig. 3. Daily count of Arctic char passing through the Tugaat River weir, August 1992.

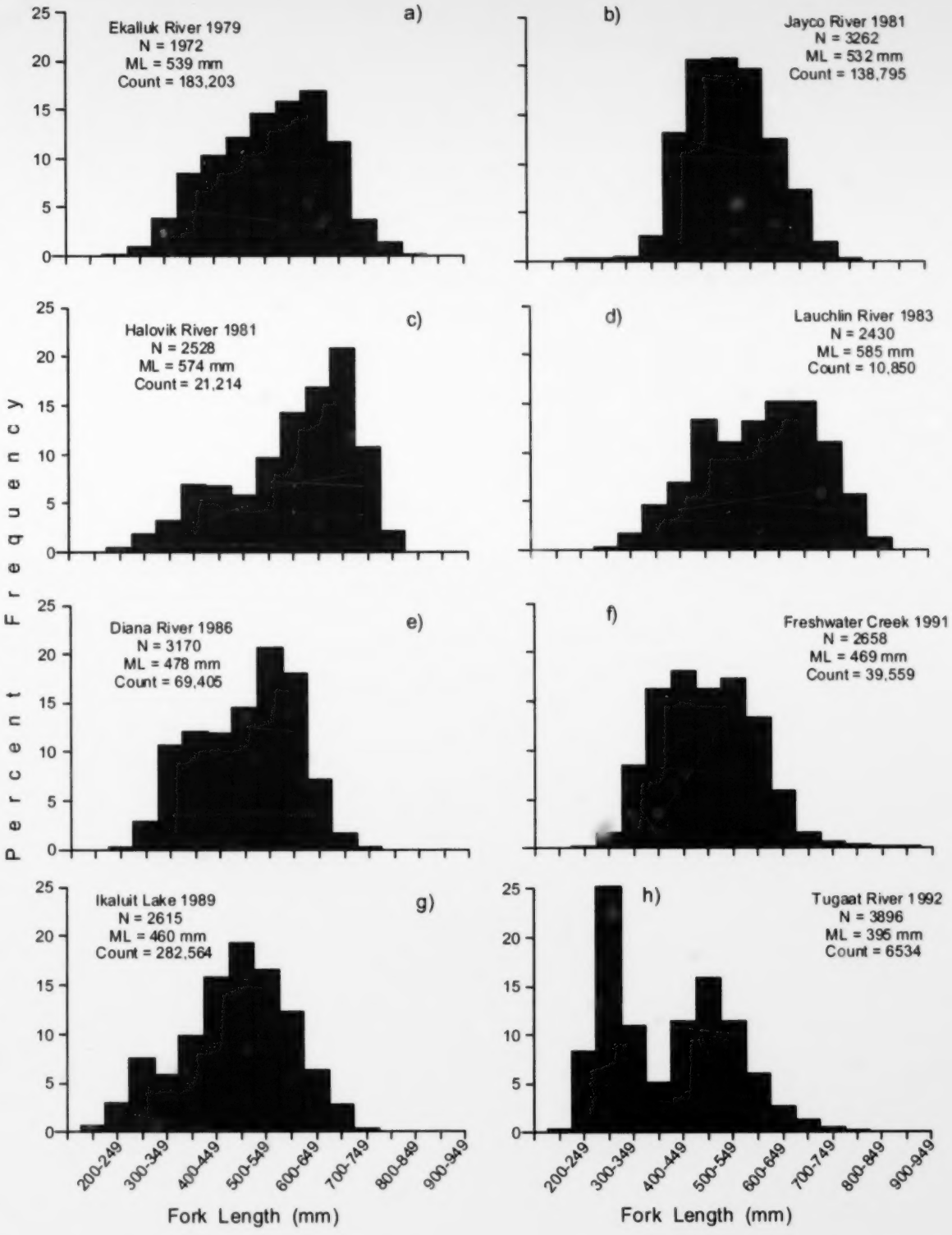

Fig. 4. Length-frequency distributions of Arctic char from selected weir studies in the Canadian Arctic [a), b), c) & d) from McGowan 1990; e) from McGowan 1987; f) from McGowan and Low 1992; g) from Read 2003].

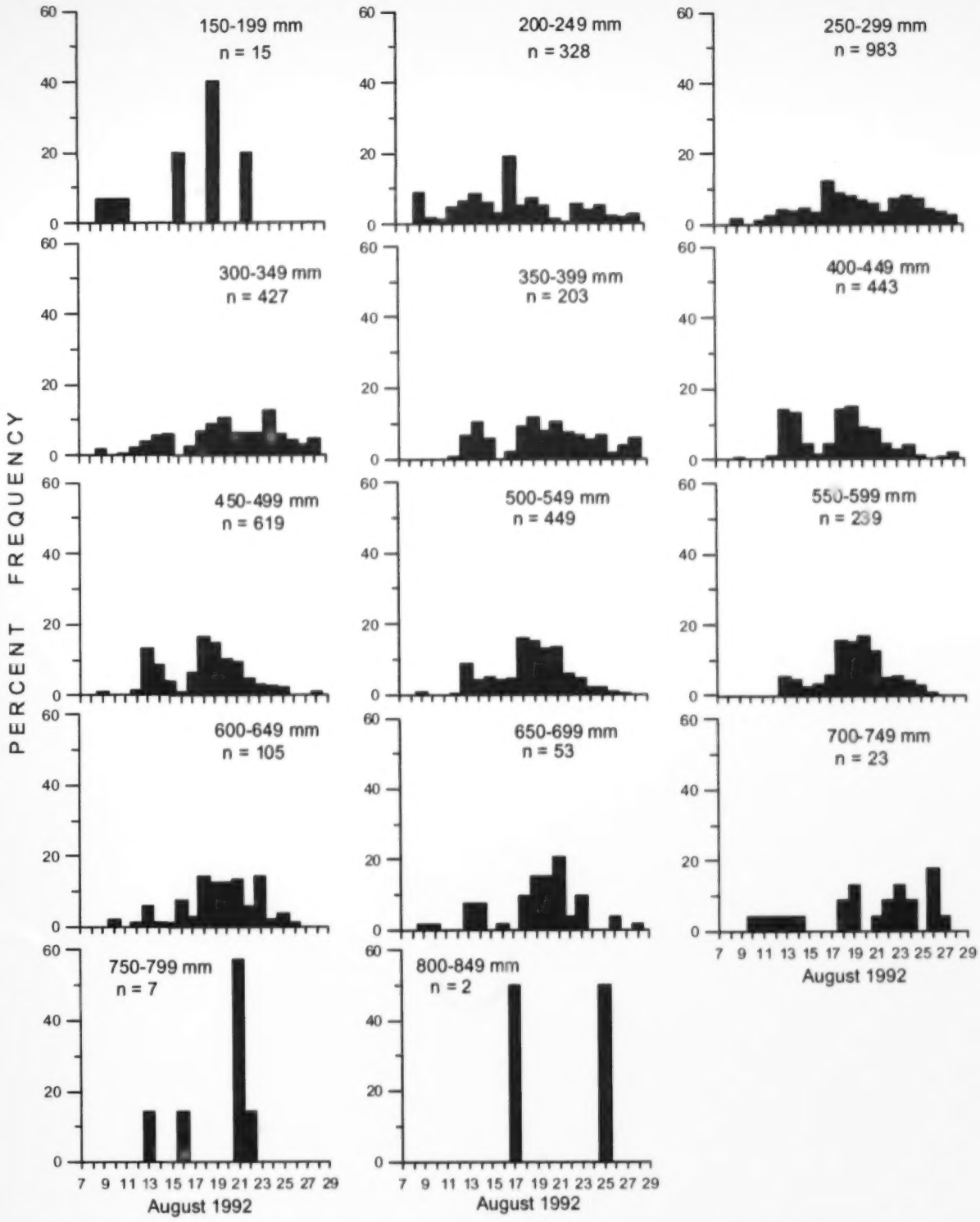

Fig. 5. Daily frequency distribution by length interval for Arctic char sampled (live and tag) at the Tugaat River weir, August 1992.

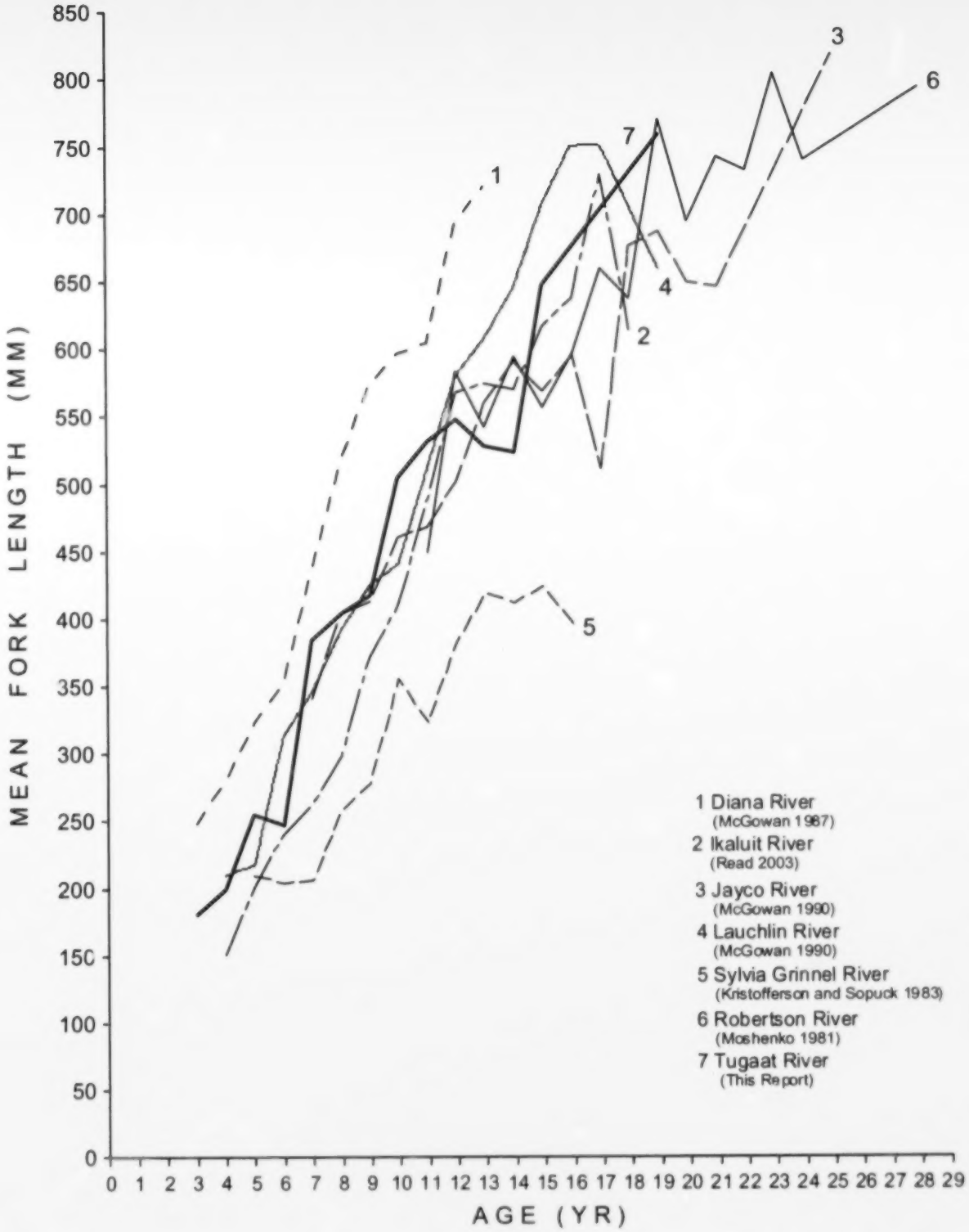

Fig. 6. Growth rates of selected Arctic char populations in Nunavut.

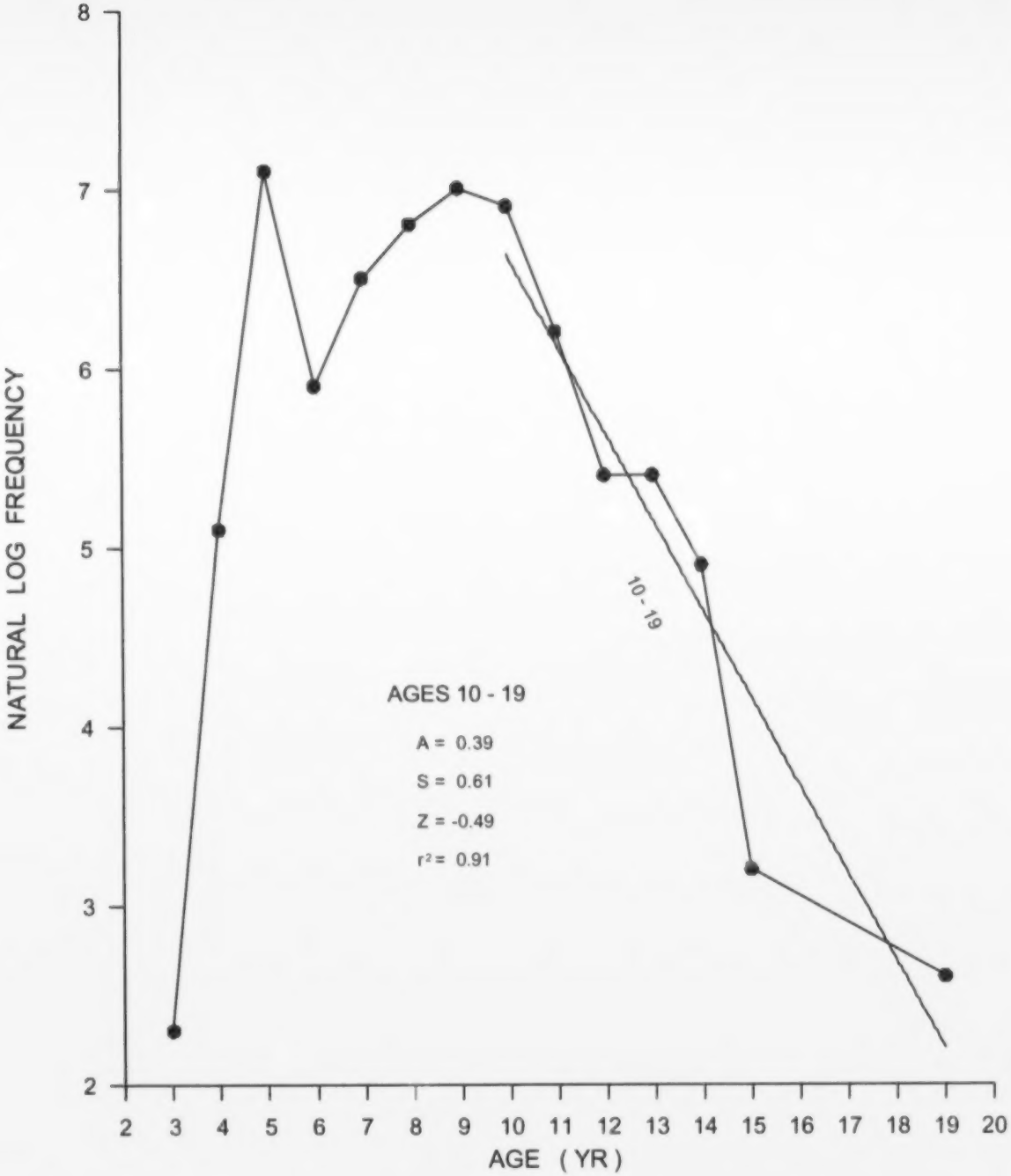

Figure 7. Catch curve for estimated age frequency distribution for the upstream migration of Arctic char, Tugaat River, August 1992.

Table 1. Commercial fishing information for Tugaat River, 1977 to 1997 (from Yaremchuk et al. 1989 and Department of Fisheries and Oceans 1988-1989 to 1995-1996).

Year	Quota (kg)	Harvest (kg)
1977	1361	1602
1978	1361	Data not available
1979	1361	Data not available
1980	1361	1360
1982	1400	1400
1983	1400	169
1984	1400	1363
1985	1000	134
1986	1000	1000
1987	1000	Data not available
1988	1000	No fishing
1989/90*	1000	No fishing
1990/91	1000	329
1991/92	1000	No fishing
1992/93	1000	No fishing
1993/94	Closed	Closed to fishing
1994/95	Closed	Closed to fishing
1995/96	Closed	Closed to fishing
1996/97	6800**	180

* Annual reporting changed from calendar year to 01 November of one year to 31 October of next year.

** Experimental license for the Koluctoo Bay/Milne Inlet area, including Tugaat River (see Fig.1). Harvest indicated is for Tugaat River.

Table 2. Summary of the number of Arctic char sampled (live, tags and dead), the length-freqency distribution and the daily count from the Tugaat River weir, August 1992.

August	Daily Count	Number Sampled				Sample Length-Frequency Distribution (mm)													
		Live	Tagged	Dead	Total	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	600 - 649	650 - 699	700 - 749	750 - 799	800 - 849
9	68	57	11		68	1	30	18	8		2	5	3			1			
10	20	7	5	8	20	3	9	1				2			2	1	1	1	
11	23	22	1		23	1	4	14	3								1		
12	134	52	18	16	86	2	22	31	12	1	5	10	1		1		1		
13	307	89	212	3	304		21	43	18	13	62	81	39	13	6	4	1	1	
14	521	100	160	4	264	3	30	40	24	21	59	53	19	11	1	4	1		
15	181	99	77	5	181	5	21	47	25	12	19	23	22	6	1				
16	95	43	47	5	95		10	31	1		6	9	20	8	8	1		1	
17	584	204	103	10	317	8	62	123	13	4	23	42	21	15	3		2		1
18	486	136	312		448		17	88	30	18	62	102	71	37	15	5	3		
19	1180	148	300	19	467	10	24	78	39	25	69	94	68	36	14	9	1		
20	836	132	237	5	374		17	67	46	19	41	63	58	41	13	8	1		
21	963	91	234	58	383		4	69	32	27	40	66	66	37	22	15	2	4	
22	221	63	115	3	181	1	2	35	28	15	20	29	26	13	6	2	3	1	
23	215	94	118	2	214		18	71	28	13	11	18	20	13	15	5	2		
24	227	87	124	16	227		13	80	56	12	17	16	10	12	7	2	2		
25	198	74	98	11	183		17	71	28	16	5	14	11	7	5	3	5		1
26	112	8	74	30	112		12	49	22	9	2	5	6	2	2		1		
27	75	6	57	12	75		6	32	15	7	4	3	4	2	1	1			
28	88	17	66	5	88		9	27	21	13	9	6		1		1	1		
	6534	1529	2369	212	4110	34	348	1015	449	225	456	641	465	254	122	62	28	8	2

Table 3. Biological data by length interval for Arctic char tagged and live sampled at the Tugaat River weir, August 1992.

LENGTH INTERVAL (MM)	NO.	PERCENT	MEAN FORK LENGTH(MM)	ROUND WEIGHT(G) MEAN	ROUND WEIGHT(G) SD	K
150-199	15	0.4	190	59	23	0.85
200-249	328	8.4	233	147	48	1.12
250-299	983	25.2	271	216	50	1.09
300-349	427	11.0	322	360	72	1.08
350-399	203	5.2	376	612	173	1.14
400-449	443	11.4	425	936	211	1.21
450-499	619	15.9	474	1310	190	1.22
500-549	449	11.5	521	1780	264	1.25
550-599	239	6.1	571	2346	410	1.26
600-649	105	2.7	620	2996	436	1.26
650-699	53	1.4	671	3990	594	1.32
700-749	23	0.6	718	4763	621	1.29
750-799	7	0.2	757	5164	847	1.19
800-849	2	0.1	827	6125	389	1.08
TOTAL	3896					
MEAN			395	1061	950	1.17

Table 4. Average growth of Arctic char tagged at the Tugaat River weir in August 1992 and recaptured in February 1995 and December 2000.

Length interval at tagging	Recaptured in 1995 N	Average growth/ fish/yr (mm)	Range (mm/yr)	Recaptured in 2000 N	Av growth/ fish/yr (mm)	Range (mm/yr)
350 - 399				1	29	
400 - 449	13	72	50- 145	4	31	26- 33
450 - 499	21	66	41- 113	9	24	20- 29
500 - 549	22	60	12- 93			
550 - 599	10	50	21- 72	1	14	
600 - 649	6	40	12- 67	1	29	
650 - 699	3	32	21- 38			
700 - 749	1	79				
Total	76	60	12- 145	16	26	14- 33

Table 5. Biological data by age class for the dead sample of Arctic charr at the Tugaat River weir, August 1992.

AGE	MALES							FEMALES							TOTAL*						
	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%	LENGTH (MM)			WEIGHT (G)			%
(YR)	N	MEAN	SD	MEAN	SD	K	MAT	N	MEAN	SD	MEAN	SD	K	MAT	N	MEAN	SD	MEAN	SD	K	MAT
3	-	-	-	-	-	-	-	2	182	11	50	0	0.84	0	3	181	8	50	0	0.85	0
4	5	205	31	95	51	1.02	0	4	209	30	100	58	1.00	0	16	200	24	83	47	0.94	0
5	4	292	36	300	129	1.14	0	10	261	34	210	97	1.11	0	28	255	40	199	104	1.10	0
6	2	283	81	225	177	0.88	0	4	257	23	175	50	1.01	0	10	247	50	168	101	0.98	0
7	4	469	60	1200	481	1.11	50	5	352	68	530	266	1.11	0	11	385	92	741	493	1.12	18
8	6	438	69	983	438	1.09	0	8	378	91	700	448	1.11	0	14	404	85	821	451	1.10	0
9	6	465	89	1267	749	1.11	33	7	426	102	986	652	1.08	0	16	417	104	947	714	1.02	13
10	10	522	99	1755	995	1.11	40	5	481	130	1510	1183	1.06	20	16	505	104	1631	1004	1.09	31
11	5	676	51	4230	1314	1.34	100	7	503	126	1664	930	1.12	57	15	532	148	2283	1763	1.17	60
12	2	542	217	2425	2440	1.22	50	5	588	120	2440	1155	1.09	60	8	548	145	2188	1451	1.11	50
13	1	744	-	5200	-	1.26	100	4	569	145	2300	1517	1.08	50	7	528	177	2164	1941	1.07	43
14	1	597	-	2100	-	0.99	100	1	389	-	650	-	1.10	0	3	524	117	1550	786	1.01	33
15	1	648	-	2550	-	0.94	100	-	-	-	-	-	-	-	1	648	-	2550	-	0.94	100
19	1	760	-	3900	-	0.89	100	-	-	-	-	-	-	-	1	760	-	3900	-	0.89	100
TOTAL	48							62							149						
MEAN		468	163	1619	1511	1.11			389	149	963	1030	1.08			383	160	991	1209	1.06	
MEAN AGE	8.8							8.2							8.0						

* males, females and unknowns

Table 6. Summary of biological data of Arctic char from selected weir studies (upstream migrations) in the Canadian Arctic, 1979-1992.

Weir Site	Year	Total Count	Number Sampled *	Mean Length (mm)	Modal Length Interval	Mean Age **	K	F:M Ratio	Age at First Maturity F	Age at First Maturity M
Tugaat River	1992	6534	3896	395	250-299	8.0	1.17	1.3:1.0	10	7
Ikaluit River [1]	1989	282,564	2615	460	450-499	10.0	1.28	0.7:1.0	7	5
Ekalluk River [2]	1979	183,203	1972	539	600-649	10.7	1.18	0.8:1.0	11	9
Halovik River [2]	1981	21,214	2528	574	650-699	10.1	1.37	1.5:1.0	12	12
Jayco River [2]	1981	138,795	3262	532	450-550	12.1	1.14	0.8:1.0	10	12
Lauchlin River [2]	1983	10,850	2430	585	600-749	11.5	1.31	0.9:1.0	12	13
Diana River [3]	1986	69,405	3170	-	500-549	8.1	-	0.5:1.0	5	8
Freshwater Creek [4]	1991	39,559	2813	469	400-449	8.2	1.16	1.3:1.0	12	8

[1] Pond Inlet area (Read, 2003)
[2] Cambridge Bay area (McGowan 1990)
[3] Rankin Inlet area (McGowan 1987)
[4] Cambridge Bay area (McGowan and Low 1992)
* tags and live sample
** dead sample

Table 7. Number, date and location of tags recovered from Arctic char tagged at Tugaat River, August 1980.

Date of Recapture		Number of Recaptures	Location of Recapture
Month	Year		
November	1980	2	Tugaat Lake
November	1981	75	Tugaat Lake
August	1982	6	Tugaat River
November	1982	14	Tugaat Lake
August	1983	2	Tugaat River
December	1984	1	Tugaat Lake
November	1985	3	Tugaat Lake
November	1986	2	Tugaat Lake
Unknown		1	Tugaat River
Total		106	

* The recapture location was not designated for one of the tag returns.

Table 8. Summary of tag recapture information from Arctic char tagged at Tugaat River weir, August 1992.

Date of Recapture	Number of Recaptures	Location of Recapture	Estimated * Minimum Harvest (kg)	Remarks
July/August 1994	27	Milne Inlet	84	23 tag returns from one fisher
February 1995	85	Tugaat Lake	680	Three fishermen caught 680 kg of charr in 6 days of which 84 were tagged (av wt 3.1 kg)
August 1995	33	Milne Inlet	#180 + 37= 217	21 tag returns from Exploratory Fishery
	19	Tugaat River	59	12 from one fisher
February 1996	30	Tugaat Lake	93	30 tag returns from one fisher
	1	Ikaluit Lake	3.1	
August 1997	17	Milne Inlet	216	
June 1998	5	Tugaat River	16	5 tag returns from one fisher
August 1998	6	Milne Inlet	93	One fisher caught 6 tags (30 fish) 3 days fishing
December 1998	20	Tugaat Lake	1008	Three fishers fished for approx. 36 hrs and caught approx. 325 fish...big fish.
March 1999	3	Tugaat Lake	9	Resource Officer caught 3 tags (3.5 inch mesh)
August 1999	3	Tugaat River	9	
September 1999	5	Tugaat River	16	One fisher
November 1999	4	Tugaat Lake	12.4	
December 1999	29	Tugaat Lake	645	One fisher caught 10 tags (208 fish).
			43	One fisher caught 14 tags.
			233	One fisher caught 5 tags (75 fish).
Unknown 2000	1	Tugaat Lake	2	
February 2000	2	Tugaat Lake	5	
March 2000	4	Tugaat Lake	9	
May 2000	1	Ikaluit Lake	2	
	7	Tugaat Lake	16	
June 2000	3	Tugaat Lake	7	
August 2000	1	Tugaat River	2	
August 2000	1	Milne Inlet	2	
December 2000	17	Tugaat Lake	874	Four fishers caught 9, 1, 3 & 4 tags resp.
February 2001	1	Tugaat Lake	2	
March 2001	14	Tugaat Lake	350	One fisher caught 5 tags (152 fish)
			580	One fisher caught 5 tags (252 fish)
June 2001	11	Tugaat Lake	97	One fisher caught 5 tags (42 fish in 3 days of fishing with one net)
			14	Another fisher caught 5 tags
May 2002	4	Tugaat Lake	92	One fisher caught 40 fish and 4 tags
June 2002	1	Tugaat River	2	
Nov/Dec 2002	8	Tugaat Lake		
June 2003	2	Tugaat River		
TOTAL	365			
	281	Tugaat River/Lake		
	84	Milne Inlet		

Note : All fish designated as being recaptured in Milne Inlet were said to be caught in one of three locations: 'Milne Inlet' (exact location not indicated) or else Ipitalik Peninsula or Deep Cove both of which are in Milne Inlet approximately 15 km north of Tugaat River.

* 3.1 kg per fish was used up to 2000 (average of Feb 95 sample) when 2.3kg was used (average of Dec 2000 sample)

180 kg from exp fishery (see M & M)

Table 9. Summary of biological data for Arctic char harvested by gill net, Tugaat River and Lake, 1975-2000.

Type of Fishery	Year	Month	Mesh Size (mm)	Length			Age			K
				N	Mean	Modal	N	Mean	Modal	
upstream	1980	August	140	97	550	650	76	14.3	11.0	*
upstream	1995	August	140	30	713	800	26	13.0	12.0	1.33
winter	1975	May	127	100	667	700	74	16.3	18.0	1.06
winter	1985	December	140	100	569	600	—	—	—	1.24
winter	1996	February	114 & 140	100	626	600	94	11.4	12.0	1.08
winter	2000	December	89 & 140	386	591	600	—	—	—	1.03

* dressed weights

App. 1. A description of the codes used to designate the relative stages of maturity for northern fishes.

Fish Maturity Codes				
Maturity State		Female		Male
Immature (virgin)	1	- ovaries granular in texture - hard and triangular in shape - up to full length of body cavity - membrane full	6	- testes long and thin - tubular and scalloped shape - up to bull body length - putty-like firmness
Mature	2	- current year spawner - ovary fills body cavity - eggs near full size but not loose - not expelled by pressure	7	- current year spawner - testes large and lobate - white to purplish colour - centers may be fluid - milt not expelled by pressure
Ripe	3	- ovaries greatly extended and fill body cavity - eggs full size and transparent - eggs expelled by slight pressure	8	- testes full size - white and lobate - milt expelled by slight pressure
Spent	4	- spawning complete - ovaries ruptured and flaccid - developing oocytes visible - some retained eggs in body cavity	9	- spawning complete - testes flaccid with some milt - blood vessels obvious - testes violet-pink in colour
Resting	5	- ovary 40-50% of body cavity - membrane thin, loose, and semi-transparent - healed fromspawning - developing oocytes apparent with few atretic eggs - some eggs may be retained in body cavity	10	- testes tubular, less lobate - healed from spawning - no fluid in center - usually full length - mottled and purplish in colour
Unknown (virgin)	0	- cannot be sexed - gonads long or short and thin - transparent or translucent		
Unknown (non-virgin)	11	- resting - has spawned but gonads regenerated - sexing not possible		

App. 2. Biological data by length interval for Arctic char sampled from 127 mm mesh gill nets, Tugaat Lake, May 1975.

LENGTH INTERVAL (MM)	MALES					FEMALES					TOTAL*					
		LENGTH (MM)	WEIGHT (G)				LENGTH (MM)	WEIGHT (G)				LENGTH (MM)	WEIGHT (G)			%
	N	MEAN	MEAN	SD	K	N	MEAN	MEAN	SD	K	N	MEAN	MEAN	SD	K	FEMALE
550-599	1	560	1928	-	1.10	3	582	2079	66	1.06	4	576	2041	93	1.07	75
600-649	5	622	2449	306	1.01	26	620	2516	288	1.05	31	620	2505	287	1.05	84
650-699	5	676	3606	325	1.17	38	669	3174	321	1.06	43	670	3224	347	1.07	88
700-749	8	716	3998	337	1.09	5	702	3402	331	0.98	13	711	3769	440	1.05	38
750-799	6	777	4806	707	1.03	-	-	-	-	-	6	777	4806	707	1.03	-
800-849	2	805	5217	962	1.00	-	-	-	-	-	2	805	5217	962	1.00	-
850-899	1	850	7258	-	1.18	-	-	-	-	-	1	850	7258	-	1.18	-
TOTAL	28					72					100					
MEAN		711	3954	1210	1.07		650	2906	479	1.05		667	3200	887	1.06	72

* males, females and unknowns

App. 3. Biological data by age class for Arctic char sampled from 127 mm mesh gill nets, Tugaat Lake, May 1975.

AGE (YR)	MALES N	%	LENGTH (MM) MEAN	SD	WEIGHT (G) MEAN	SD	K	FEMALES N	%	LENGTH (MM) MEAN	SD	WEIGHT (G) MEAN	SD	K	TOTAL* N	%	LENGTH (MM) MEAN	SD	WEIGHT (G) MEAN	SD	K	% FEMALE
12	1	5	610	-	2381	-	1.05	-	-	-	-	-	-	-	1	1	610	-	2381	-	1.05	-
13	1	5	720	-	4083	-	1.09	1	2	600	-	2041	-	0.94	2	3	660	85	3062	1444	1.02	50
14	3	14	617	55	2457	645	1.04	9	17	629	25	2668	479	1.06	12	16	626	32	2616	501	1.06	75
15	1	5	670	-	3629	-	1.21	12	23	640	38	2731	447	1.04	13	18	642	38	2800	495	1.05	92
16	2	9	675	49	3516	803	1.13	13	25	658	33	3027	468	1.05	15	20	661	34	3092	513	1.06	87
17	4	18	748	41	4480	439	1.08	9	17	680	11	3327	196	1.06	13	18	701	39	3681	617	1.07	69
18	4	18	693	57	3459	900	1.02	3	6	647	15	2930	558	1.08	7	9	673	48	3233	768	1.05	43
19	5	23	732	60	4468	1000	1.13	2	4	640	14	2949	320	1.13	7	9	706	67	4034	1111	1.13	29
20	1	5	680	-	3515	-	1.12	2	4	650	42	2722	802	0.98	3	4	660	35	2986	729	1.02	67
22	-	-	-	-	-	-	-	1	2	680	-	3289	-	1.05	1	1	680	-	3289	-	1.05	-
TOTAL	22							52							74							
MEAN			695	63	3732	993	1.09			650	33	2914	484	1.05			664	48	3157	768	1.06	70
MEAN AGE			16.8							16.0							16.3					

* males, females and unknowns

App. 4. Biological data by length interval for Arctic char sampled from 127 mm mesh gill nets, Tugaat Lake, December 1975.

LENGTH INTERVAL (MM)	MALES					FEMALES					TOTAL*					
		LENGTH (MM)	WEIGHT (G)				LENGTH (MM)	WEIGHT (G)				LENGTH (MM)	WEIGHT (G)			%
	N	MEAN	MEAN	SD	K	N	MEAN	MEAN	SD	K	N	MEAN	MEAN	SD	K	FEMALE
500-549	1	520	1588	-	1.13	-	-	-	-	-	1	520	1588	-	1.13	-
550-599	1	550	1701	-	1.02	1	580	1928	-	0.99	2	565	1815	161	1.01	50
600-649	1	620	1814	-	0.76	2	630	2014	38	0.81	3	627	1947	119	0.79	67
650-699	1	650	2155	-	0.78	1	690	2441	-	0.74	2	670	2298	202	0.76	50
700-749	1	720	3062		0.82	-	-	-	-	-	2	710	3346	401	0.94	-
750-799	1	780	4309	-	0.91	-	-	-	-	-	1	780	4309	-	0.91	-
TOTAL	6					4					11					
MEAN		640	2438	1061	0.90		633	2099	232	0.84		643	2423	875	0.89	40

* males, females and unknowns

App. 5. Biological data by age class for Arctic char sampled from 127 mm mesh gill nets, Tugaat River, December 1975.

AGE (YR)	MALES							FEMALES							TOTAL							
			LENGTH (MM)		WEIGHT (G)					LENGTH (MM)		WEIGHT (G)					LENGTH (MM)		WEIGHT (G)			%
	N	%	MEAN	SD	MEAN	SD	K	N	%	MEAN	SD	MEAN	SD	K	N	%	MEAN	SD	MEAN	SD	K	FEMALE
13	-	-	-	-	-	-	-	1	50	620	-	1987	-	0.83	1	25	620	-	1987	-	0.83	-
19	1	100	720	-	3062	-	0.82	-	-	-	-	-	-	-	2	50	710	14	3346	401	0.94	-
20	-	-	-	-	-	-	-	1	50	690	-	2441	-	0.74	1	25	690	-	2441	-	0.74	-
TOTAL	1							2							4							
MEAN			720	-	3062	-	0.82			655	49	2214	321	0.79			683	43	2780	717	0.86	67
MEAN AGE			19.0							16.5							17.8					

* males, females and unknowns

App. 6. Biological data by length interval for Arctic char sampled from 140 mm mesh gill nets, Tugaat River, August 1980.

LENGTH INTERVAL (MM)	NO.	PERCENT	MEAN FORK LENGTH (MM)	DRESSED WEIGHT (G) MEAN	DRESSED WEIGHT (G) SD
350-399	5	5	392	670	67
400-449	17	18	421	809	83
450-499	13	13	469	1158	151
500-549	12	12	526	1604	167
550-599	11	11	575	2005	220
600-649	20	21	622	2395	163
650-699	14	14	667	3111	404
700-749	4	4	726	3825	343
750-799	1	1	773	3800	-
TOTAL	97				
MEAN			550	1897	936

App. 7. Biological data by age class for Arctic char sampled from 140 mm mesh gill nets, Tugaat River, August 1980.

AGE (YR)	NO.	PERCENT	FORK LENGTH (MM) MEAN	FORK LENGTH (MM) SD	DRESSED WEIGHT (G) MEAN	DRESSED WEIGHT (G) SD
10	7	9	416	27	807	134
11	18	24	444	44	1000	334
12	13	17	490	58	1335	451
13	4	5	507	54	1388	411
14	3	4	477	71	1167	562
15	3	4	601	32	2050	250
16	2	3	617	90	2500	1344
17	9	12	648	60	2789	631
18	3	4	666	69	3250	1050
19	3	4	660	35	3133	629
20	7	9	647	31	2771	454
21	1	1	617	-	2350	-
22	2	3	642	19	2650	495
24	1	1	635	-	2500	-
TOTAL	76					
MEAN			535	104	1776	957
MEAN AGE	14.3					

App. 8. Biological data by length interval for Arctic char sampled from 127 mm mesh gill nets, Tugaat Lake, December 1985.

LENGTH INTERVAL (MM)	NO.	PERCENT	MEAN FORK LENGTH (MM)	ROUND WEIGHT (G) MEAN	ROUND WEIGHT (G) SD	K
300-349	2	2	323	375	35	1.12
350-399	2	2	368	500	212	0.98
400-449	1	1	445	750	-	0.85
450-499	2	2	460	1350	283	1.38
500-549	13	13	536	2046	227	1.32
550-599	48	48	568	2335	237	1.27
600-649	28	28	616	2771	300	1.18
650-699	3	3	660	3833	486	1.33
700-749	1	1	720	4150	-	1.11
TOTAL	100					
MEAN			569	2372	647	1.24

App. 9. Biological data by length interval for Arctic charr sampled from 140 mm mesh gill nets, Tugaat River (Koluctoo Bay Experimental Fishery), August 1995.

LENGTH INTERVAL (MM)	MALES					FEMALES					TOTAL *					
		LENGTH (MM)	WEIGHT (G)				LENGTH (MM)	WEIGHT (G)				LENGTH (MM)	WEIGHT (G)			%
	N	MEAN	MEAN	SD	K	N	MEAN	MEAN	SD	K	N	MEAN	MEAN	SD	K	FEMALE
600-649	1	600	2500	-	1.16	5	624	3080	239	1.27	6	620	2983	319	1.25	83
650-699	4	668	3925	299	1.32	2	655	3900	141	1.39	6	663	3917	240	1.34	33
700-749	4	733	5350	311	1.36	2	700	4800	1131	1.40	6	722	5167	628	1.37	33
750-799	8	770	6388	594	1.40	1	770	5500	-	1.20	9	770	6289	629	1.38	11
800-849	3	813	6633	493	1.23	-	-	-	-	-	3	813	6633	493	1.23	-
TOTAL	20					10					30					
MEAN		740	5530	1311	1.34		660	3830	1001	1.31		713	4963	1450	1.33	33

* includes fish of unknown sex

App. 10. Biological data by age class for Arctic char sampled from 140 mm mesh gill nets, Tugaat Lake (Koluctoo Bay Experimental Fishery), August 1995.

AGE	MALES							FEMALES							TOTAL *							
			LENGTH (MM)		WEIGHT (G)					LENGTH (MM)		WEIGHT (G)					LENGTH (MM)		WEIGHT (G)			
(YR)	N	%	MEAN	SD	MEAN	SD	K	N	%	MEAN	SD	MEAN	SD	K	N	%	MEAN	SD	MEAN	SD	K	% FEMALE
10	4	20	708	88	4675	1700	1.29	2	33	615	21	3100	424	1.33	6	23	677	84	4150	1559	1.30	33
11	1	5	720	-	4900	-	1.31	1	17	660	-	4000	-	1.39	2	8	690	42	4450	636	1.35	50
12	5	25	730	77	5360	1629	1.33	2	33	625	21	3000	141	1.24	7	27	700	82	4686	1760	1.30	29
13	4	20	750	47	5925	1350	1.39	-	-	-	-	-	-	-	4	15	750	47	5925	1350	1.39	-
14	1	5	740	-	5500	-	1.36	-	-	-	-	-	-	-	1	4	740	-	5500	-	1.36	-
16	2	10	775	7	6500	849	1.40	-	-	-	-	-	-	-	2	8	775	7	6500	849	1.40	-
18	3	15	770	30	6000	529	1.31	-	-	-	-	-	-	-	3	12	770	30	6000	529	1.31	-
21	-	-	-	-	-	-	-	1	17	770	-	5500	-	1.20	1	4	770	-	5500	-	1.20	-
TOTAL	20							6							26							
MEAN			740	59	5530	1311	1.34			652	62	3617	1019	1.29			720	70	5088	1480	1.33	23
MEAN AGE			13.2							12.7							13.0					

* includes fish of unknown sex

App. 11. Biological data by length interval for Arctic char sampled from 114 mm and 140 mm mesh gill nets, Tugaat Lake, February 1996.

LENGTH INTERVAL (MM)	MALES					FEMALES					TOTAL*					
		LENGTH (MM)	WEIGHT (G)				LENGTH (MM)	WEIGHT (G)				LENGTH (MM)	WEIGHT (G)			%
	N	MEAN	MEAN	SD	K	N	MEAN	MEAN	SD	K	N	MEAN	MEAN	SD	K	FEMALE
400-449	2	437	806	40	0.97	-	-	-	-	-	2	437	806	40	0.97	-
450-499	2	484	1104	82	0.98	3	485	1583	605	1.39	5	484	1391	504	1.22	60
500-549	3	524	1567	154	1.09	2	530	1619	372	1.08	5	526	1588	217	1.09	40
550-599	7	578	2120	212	1.09	14	584	2134	247	1.07	21	582	2129	230	1.08	67
600-649	15	624	2544	341	1.05	17	620	2639	270	1.11	32	621	2595	304	1.08	53
650-699	13	681	3388	413	1.07	8	669	3156	387	1.05	21	676	3299	410	1.06	38
700-749	8	719	4040	301	1.09	1	704	3670	-	1.05	9	718	3999	308	1.08	11
750-799	4	768	4829	90	1.07	-	-	-	-	-	4	768	4829	90	1.07	-
800-849	1	802	6600	-	1.28	-	-	-	-	-	1	802	6600	-	1.28	-
TOTAL	55					45					100					
MEAN		642	2978	1164	1.07		606	2481	583	1.10		626	2754	975	1.08	45

* males, females and unknow

App. 12. Biological data by age class for Arctic char sampled from 114 mm and 140 mm mesh gill nets, Tugaat Lake, February 1996.

AGE	MALES							FEMALES							TOTAL*							
			LENGTH(MM)		WEIGHT(G)					LENGTH(MM)		WEIGHT(G)					LENGTH(MM)		WEIGHT(G)			%
(YR)	N	%	MEAN	SD	MEAN	SD	K	N	%	MEAN	SD	MEAN	SD	K	N	%	MEAN	SD	MEAN	SD	K	FEMALE
7	1	2	425	-	858	-	1.12	-	-	-	-	-	-	-	1	1	425	-	858	-	1.12	-
8	4	8	615	126	2884	1806	1.11	1	2	614	-	3136	-	1.35	5	5	615	109	2934	1568	1.16	20
9	3	6	591	75	2553	1098	1.18	2	4	519	69	1696	628	1.19	5	5	562	74	2210	960	1.18	40
10	3	6	594	20	2605	368	1.24	8	18	570	48	2416	493	1.33	11	12	576	43	2467	453	1.30	73
11	11	22	651	87	3539	1611	1.21	10	22	606	36	2709	577	1.20	21	22	630	70	3144	1276	1.21	48
12	14	29	658	47	3320	788	1.15	19	42	623	44	2921	595	1.19	33	35	638	48	3090	701	1.17	58
13	8	16	707	48	4179	918	1.17	3	7	636	60	3009	1025	1.14	11	12	687	58	3859	1048	1.16	27
14	3	6	611	158	2873	2179	1.07	2	4	625	55	2769	720	1.12	5	5	617	116	2831	1583	1.09	40
15	1	2	687	-	3090	-	0.95	-	-	-	-	-	-	-	1	1	687	-	3090	-	0.95	-
18	1	2	611	-	2390	-	1.05	-	-	-	-	-	-	-	1	1	611	-	2390	-	1.05	-
TOTAL	49							45							94							
MEAN			645	84	3282	1290	1.16			606	51	2733	641	1.21			626	72	3019	1063	1.18	48
MEAN AGE			11.5							11.4							11.4					

* males, females and unknow

App. 13. Biological data by length interval for Arctic charr sampled from 89 mm and 114 mm mesh gill nets, Tugaat Lake, December 2000.

LENGTH INTERVAL (MM)	NO.	PERCENT	MEAN FORK LENGTH (MM)	ROUND WEIGHT (G) MEAN	ROUND WEIGHT (G) SD	K
400-449	4	1	430	625	250	0.79
450-499	30	8	476	980	246	0.91
500-549	85	22	521	1442	408	1.01
550-599	97	25	572	1899	521	1.01
600-649	77	20	620	2601	424	1.09
650-699	59	15	671	3229	815	1.07
700-749	27	7	714	3981	893	1.09
750-799	2	1	765	5750	354	1.29
800-849	5	1	822	5140	2593	0.93
TOTAL	386					
MEAN			591	2265	1118	1.03